Life-Cycle of the Millipede *Melogona voigti* (Verhoeff, 1899) from a Suburban Forest in South Bohemia

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ABSTRACT

A population of the millipede *Melogona voigti* in a suburban deciduous forest in South Bohemia has been studied by soil sampling. The changes of density in the course of the year and the post-embryonic development have been described. The biological cycle was annual for the greatest part of the population. The effects of climatic factors on the life-cycle of Chordeumatida are discussed.

RÉSUMÉ

Cycle de vie du diplopode *Melogona voigti* (Verhoeff, 1899) dans une forêt suburbaine décidue du sud de la Bohème.

Une population de *Melogona voigti* d'une forêt décidue suburbaine du sud de la Bohème a été étudiée par échantillonnage du sol. Les variations de densité au cours de l'année et le développement post-embryonnaire sont décrits. Le cycle est annuel pour la plus grande partie de la population. Les effets des facteurs climatiques sur le cycle des chordeumatides sont discutés.

INTRODUCTION

Three species of the genus *Melogona* Cook, 1895 (= *Microchordeuma* Verhoeff, 1896) are distributed in Central and North-West Europe. Post-embryonic development of *M. scutellare* (Ribaut, 1913) was described by BLOWER (1978, 1979) and that of *M. gallica* (Latzel, 1884) by DAVID (1984). Some primary data for the third species *M. voigti* (Verhoeff, 1899) were published by VERHOEFF (1913, 1928) and later supplemented by SCHUBART (1957) and by DUNGER & STEINMETZGER (1981). *M. scutellare*, belonging to the subgenus *Chordeumella* Verhoeff, 1897, has eight post-embryonic stadia and adults with 28 body segments. *M. gallica* and *M. voigti* belong to the subgenus *Melogona* Cook, 1895, the adults of which have 30 body segments and mature one stadium later.

During the faunistic research in South Bohemia, a suburban forest near Ceske Budejovice was discovered to contain a population of *Melogona voigti*. To obtain data for completion of its life-cycle, soil sampling was used.

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STUDY SITE AND METHODS

The population of *Melogona voigti* was studied in the suburban deciduous forest Stromovka in south-west outskirts of Ceske Budejovice-city in South Bohemia (Czech Republic). Stromovka (430 m a.s.l., average air temperature 7.8°C, precipitation 620 mm, see Fig. 2) is an allochtonous sparse wood dominated by *Populus nigra* L. and *Alnus glutinosa* (L.) Gaertn. The plant cover consists mostly of *Urtica dioica* L. and *Filipendula ulmaria* (L.) Max. The site is characterized by brown soil type (gleic cambisol) with mull-moder to mull humus horizon, pH (H_2O) 4.4.

Ten soil samples (sampling area 1/16 m2, depth 5 cm) were taken at approximately fortnightly intervals from February 24, 1992 until April 19, 1993. Millipedes were heat extracted from soil samples by modified Kempson extraction apparatus (KEMPSON *et al.*, 1963). For the evaluation of post-embryonic development of *M. voigti*, the numbers of body segments, pairs of legs and ocelli were counted. Females were dissected and the presence or absence of eggs investigated.

RESULTS

Population density and dynamics during the year

Sequential fortnightly sampling confirmed, that the millipede *M. voigti* is active during the whole year. Mean annual density of the population under study was 60.6 ind.m2. During the winter months up to March, adults only were present (Fig. 1). The first increase in density in mid-April can be connected with the increasing activity of adults. Practically all successive peaks of density were due to culminations of separate post-embryonic stadia: 11.5. - stadium III, 26.5. - stadium IV, 13.7. - stadia V and VI, 24.8. - stadium VII, and 4.11. - stadium IX (new adults). The marked depression in mid-June was probably due to the rainfall deficiency and the consequent drying up of the litter and upper soil layer. The maximum number of adults was observed in November. In winter months the density of millipedes decreased.

Mating and oviposition

Both, mating and oviposition appeared to take place early in spring, judging from the appearance of stadium II as from the first half of April. In the field the mating was observed still in April. Dissection of females showed the presence of eggs in the ovarium from November until the end of April. Therefore it was not possible to be more precise about the time of oviposition or the number of eggs laid.

Post-embryonic stadia

Numbers of body segments (podous and apodous) and numbers of pairs of legs for individual stadia of *M. voigti* are given in Table 1. *M. voigti* has nine post-embryonic stadia. Sexual differentiation is in the last three stadia. Numbers of ocelli and their arrangement in the ocular field based on the material from South Bohemia are given in Figure 3.

TABLE 1. — Post-embryonic stadia of *Melogona voigti*. Pleurotergites - number of podous rings, apodous rings and telson, Ad = adults, F = female, M =male.

Stadium:	I	II	III	IV	V	VI	VII	VIII	IX(Ad)
pleurotergites:	6	8	11	15	19	23	26	28	30
podous:	4	5	7	10	14	18	22	25	27
apodous:	1	2	3	4	4	4	3	2	2
leg pairs:	3	5	10	16	24	32	40	46	49(F)
	"	"	"	"	"	"	39	44	45(M)

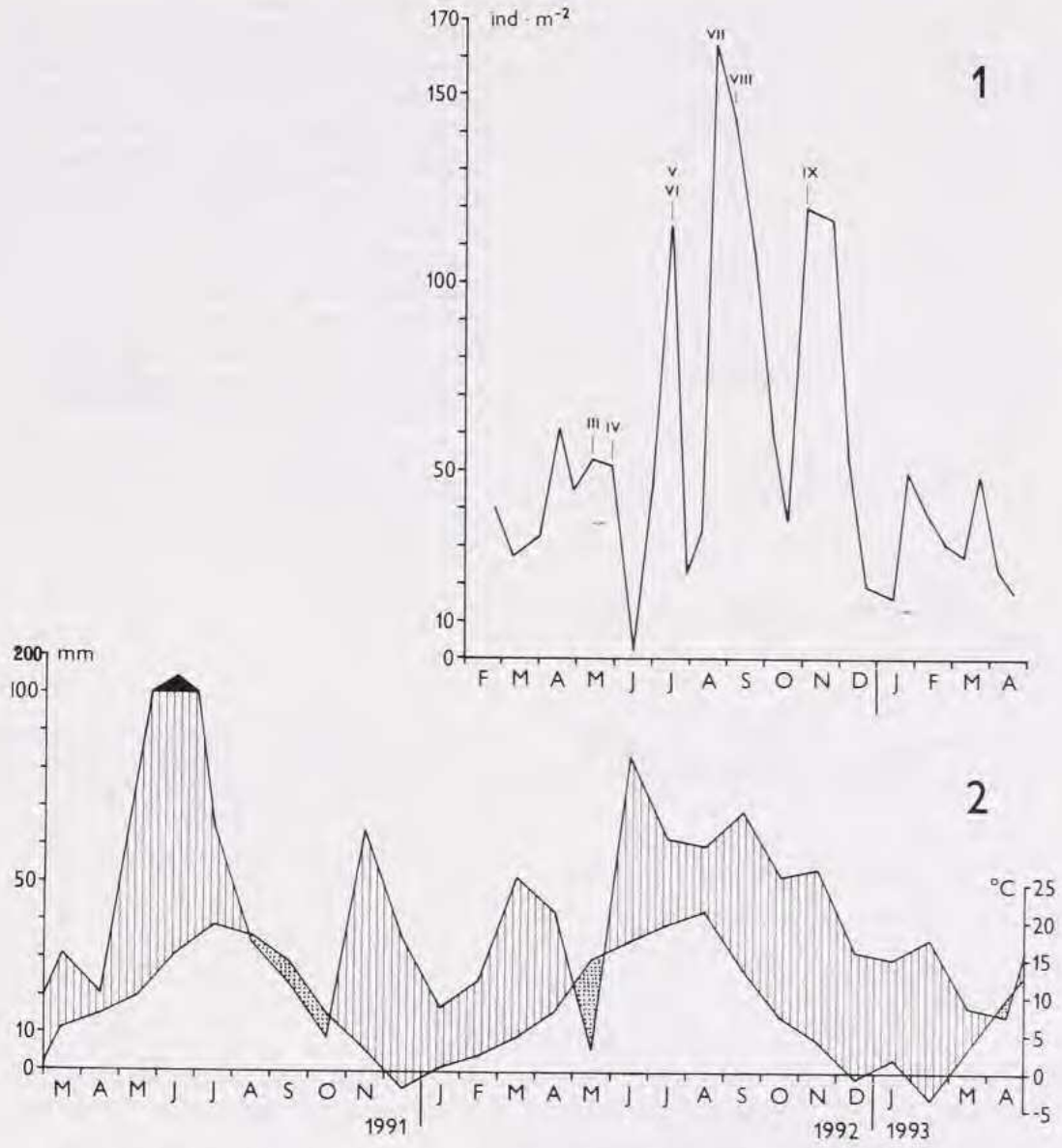
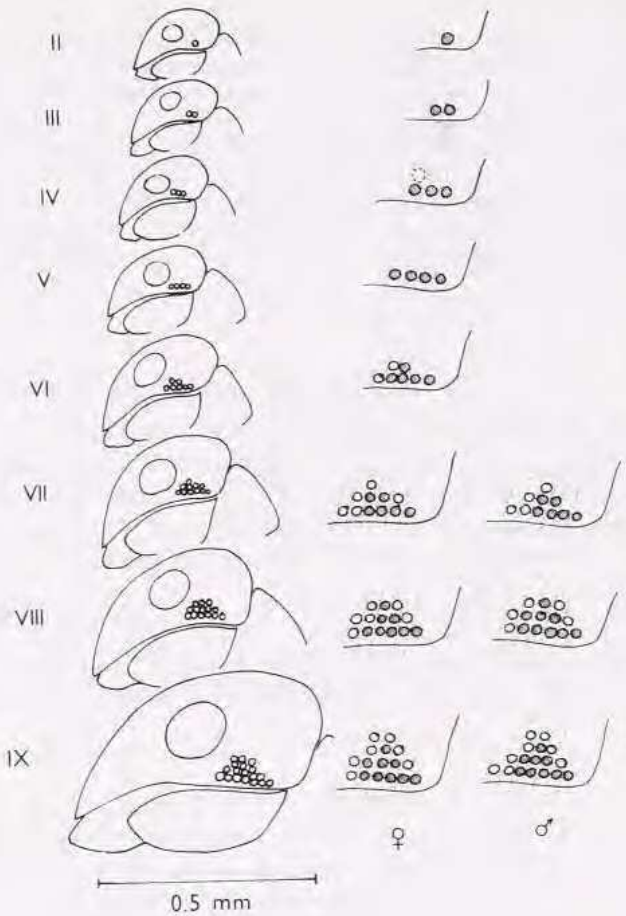


FIG. 1. — Density of dynamics of the millipede *M. voigti* showing the separate post-embryonic stadia.
FIG. 2. — Mean monthly temperature and monthly precipitations for Ceské Budejovice.

Post-embryonic development

The adults were present until the end of May (Figs 4 and 5). The first stadium was not recorded by the method used. Individuals of stadium II were noted in mid-April. Stadium III was observed from the end of April until the end of May with a maximum in the first half of May. Stadium IV appeared as from the end of May in the highest density, then it was present during the whole of June through to mid-July, and was also noted at the end of August. Stadium V was present in soil samples from the end of June until the end of August, stadium VI from mid-July up to September 21. Both stadia VII and VIII observed from the end of July and mid-August, respectively, were present up to the beginning of October. At that time the first adults (stadium IX) appeared. The absence of stadia VII and VIII in mid-October and following samples confirmed the end of post-embryonic development.



In the period March 30 - July 13, in addition to beside stadia II to VI, the individuals of stadia VI, VII and VIII were also present. This means that a smaller part of the previous year's population did not quite complete its development and overwintered in the same locality as stadia VI and/or VII and VIII. The successive sampling did not quite elucidate, whether this part of the population finished their development during this second year. During the next March and April 1993, the younger overwintering stadia VI, VII and VIII were not sampled.

M. voigti is therefore largely an annual millipede, however a part of the population can take more than one year to complete its life-cycle.

FIG. 3. — Growth of the ocular field from stadium II to maturity. Ocelli invariably present are cross-hatched, ocelli not always present are open, the rows of ocelli are marked.

DISCUSSION

Numbers of body segments and numbers of pairs of legs for individual stadia of *M. voigti* correspond to the general pattern for the suborder Chordeumatidea (BLOWER, 1984) and are in agreement with the data for *M. gallica* (DAVID, 1984).

VERHOEFF (1913, 1928) described the occurrence of the adult millipedes of *M. voigti* from October until May and of the juveniles in the remaining part of the year. SCHUBART (1957) confirmed these data, and DUNGER & STEINMETZGER (1981) found the adults even in mid-June. In contrast to VERHOEFFs' data (VERHOEFF, 1928), the appearances of individual stadia III to VII were always later and the development up to stadium IX was shorter (Fig. 5). In this way, post-embryonic development of *M. voigti* differs from that of the related West-European species *M. gallica* (Fig. 5). A shorter period of development with a fast sequence of older stadia V-VIII of the population under study may be the result of the colder continental climate.

The influence of climatic factors on life-cycles of Chordeumatida is known. In addition to prolongation of the time to maturity, longevity and a general slowing down of the life-cycle with the increase in altitude and decrease in temperature (MEYER, 1990), there is evidence of the interruption of the life-cycle in a part of the population due to the unfavorable microclimatic conditions (dryness, coldness) and of the life-cycle prolongation into the following year (PEDROLI-CHRISTEN, 1978; DAVID, 1989). The prolongation of life-cycle and the suggestion of

a two year development for *M. gallica* were described for a French population (DAVID, 1984) and noted for a British population as well (BLOWER, 1984). DAVID (1984) mentioned that this phenomenon can be either regular, i.e. a certain smaller part of the population always hibernates as a juvenile stadium (in our case stadia VI, VII and/or VIII) to finish the development during the next year, or this phenomenon is evoked under certain conditions. On the other hand *M. scutellare*, probably also due to the shorter post-embryonic development with eight stadia, is only an annual species (Fig. 5).

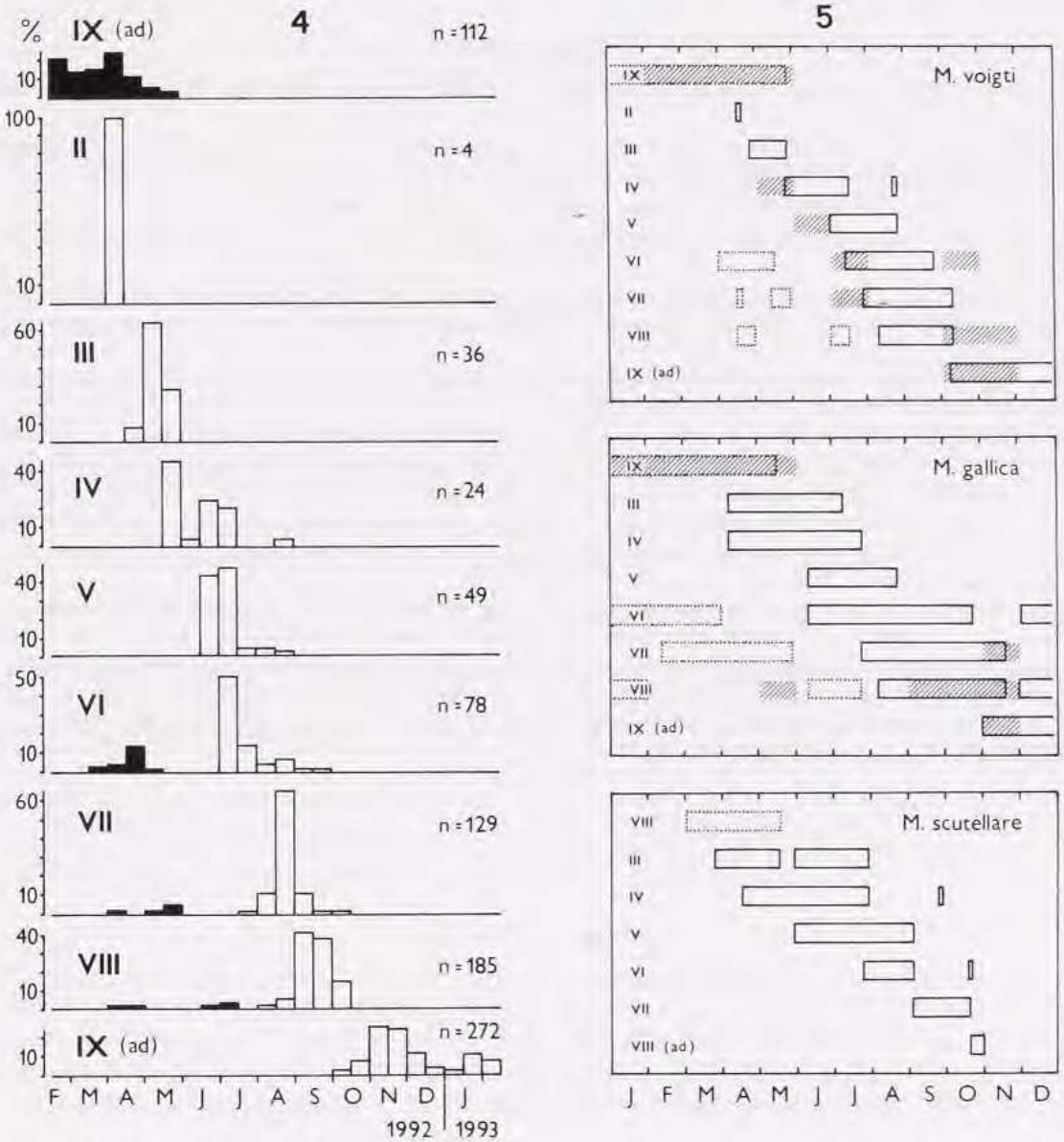


FIG. 4. — Post-embryonic development of *M. voigti* during the year. Filled fields: generation of previous year 1991.

FIG. 5. — Comparison of the life-cycles of *M. voigti*, *M. gallica* (according to DAVID, 1984), and *M. scutellare* (according to BLOWER, 1979). Areas with dotted borders - generation of previous year, cross-hatched areas - according to VERHOEFF (1928).

In 1991 a severe rainfall deficiency between August and October was observed (Fig. 2). At this time stadia VI, VII and VIII of *M. voigti* were present, which were then found again the next spring 1992. These stadia were probably minimally active and/or quite inactive in winter, because only adults were sampled. No convincing evidence about the development of this stadium VIII into stadium IX was given by subsequent sampling. Either the members of this stadium mature together with the new generation of stadium VIII or, only a small part of them mature which is difficult to find by sampling, or they do not mature at all. Consequently the absence of juvenile stadia VI, VII and/or VIII in spring 1993 is associated with favorable climatic conditions during the year 1992, when the whole population probably completed its development.

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